



Getting Real with Ammonia...

Marketing rhetoric often obscures the true nature of products and services, making it imperative to uncover the realities behind the systems we invest in. This is particularly relevant in the context of refrigerants.

While some naturally occurring gases (like CO₂ and ammonia) are often referred to interchangeably with industrially manufactured gases, failing to distinguish between them can create the false impression that certain refrigerants are entirely natural with a negligible environmental impact. All refrigerant-grade gases require rigorous industrial processes to meet purity and performance standards and involve energy consumption, feedstock, and purification processes. They are manufactured products, not simply extracted from nature in usable form.

The environmental impact of any refrigerant encompasses its entire lifecycle, making it imperative to consider how it is derived. Most ammonia production today uses the centuries-old Haber-Bosch method, which is highly energy-intensive due to the extreme conditions required for the reaction. This process involves extracting hydrogen from fossil fuels like natural gas, oil, and coal, and combining it with nitrogen at extremely high temperatures and pressures. The process generates more greenhouse gas emissions than any other industrial chemical reaction, releasing approximately 2 tons of CO₂ for every ton of usable ammonia produced. 'The

industry is responsible for about 1 to 2 percent of global carbon emissions, making it one of the dirtiest on the planet.' (Jones, 2022)

The attempt to reinvent ammonia production to make it more environmentally friendly, using water electrolysis, still uses the Haber-Bosch method and has significant natural resource impacts, such as the vast consumption of water. When revealed and properly considered, the collateral effects of ammonia manufacturing mean the chemical is far from being environmentally benign.

Considering the Complexities of Ammonia-Based Systems

Implementing ammonia-based systems in ice rinks present complexities and challenges across design, installation, and operation, involving meticulous planning and substantial investment. The engineering of these systems demands elaborate solutions, specialized components and extensive architecture to accommodate ammonia's specific properties. As a B2L refrigerant, it is both flammable and toxic. Inhalation of ammonia can be fatal – and even in small quantities, it can cause irritation to the eyes, nose, and respiratory system. Consequently, robust safety systems are critical and stringent regulations govern their use.




Mechanical rooms must be dedicated, sealed and adhere to rigorous construction standards to comply with mandates and ensure responsible operation. Required specialized equipment include fire protection systems, leak detection mechanisms, elaborate piping network, emergency shut-off valves, adequate ventilation, and evacuation alarms. Ammonia's corrosivity to certain metals, particularly copper and its alloys, requires the use of specialized, often more expensive materials, increasing the complexity and cost of ownership and repairs.

Ammonia-based systems typically use water cooling systems to regulate the temperature of compressors and evaporative condensing units to manage the heat exchange process effectively. This process involves circulating large volumes of water, leading to significant water consumption and waste. Facilities with high refrigeration loads face substantial water demand. Maintaining water quality for cooling towers and heat exchangers involves continuous chemical treatment to control pH levels and prevent biological growth, adding to ongoing maintenance costs. The disposal of treated water and sludge also poses environmental and financial challenges with increased waste and management fees.

Beyond Infrastructure:

Beyond the considerable infrastructure requirements, ammonia-based systems incur additional overhead and necessary provisions. Documentation, inspections and compliance audits for advanced leak detection systems are a regular part of the maintenance schedule. Comprehensive training programs for operators and maintenance staff on ammonia handling

and emergency procedures are essential. The risks associated with ammonia systems significantly impact liability insurance rates, resulting in higher premiums to cover potential incidents and compliance failures. These cumulative expenses for infrastructure, compliance, and insurance substantially elevate the total cost of ownership, underscoring the necessity for comprehensive cost-benefit analyses.

While ammonia is often promoted as a natural alternative to synthetic refrigerants, this marketing misrepresentation tends to overshadow its critical drawbacks. Ammonia refrigeration systems in ice rinks involve intricate design challenges, substantial investments, and significant operational demands that require expert management. Although ammonia can offer some advantageous thermodynamic properties, these benefits are quickly eliminated by the associated safety issues, costs, and complexities. These factors must be carefully assessed to determine the feasibility and sustainability of ammonia-based refrigeration solutions for such facilities. 

References

Boerner, L. K. (2019, June 15). Industrial ammonia production emits more CO₂ than any other chemical-making reaction. Chemists want to change that. Retrieved from Chemical & Engineering News: <https://cen.acs.org/environment/green-chemistry/Industrial-ammonia-production-emits-CO2/97/i24>

Jones, N. (2022, January). From Fertilizer to Fuel: Can Green Ammonia be a Climate Fix? Retrieved from Yale Environment 360: <https://e360.yale.edu/features/from-fertilizer-to-fuel-can-green-ammonia-be-a-climate-fix>

